Product-Oriented Environmental Management. Lessons from Total Quality Management

de Bakker, F.G.A.

published in
Journal of Industrial Ecology
2001

DOI (link to publisher)
10.1162/10881980152830132

document version
Publisher's PDF, also known as Version of record

Product-Oriented Environmental Management

Lessons from Total Quality Management

Frank G. A. de Bakker

Keywords

continuous improvement (CI)
life-cycle management
product stewardship
Responsible Care
stakeholders
total quality management (TQM)

Summary

Environmental management issues are becoming ever more prominent in business, and their focus is broadening from process orientation toward product orientation. Until now, little attention has been paid to an organizational focus on the environmental performance of products. This article therefore considers product-oriented environmental management (POEM), an approach to organizing and operating a firm in such a way that improving the environmental performance of its products and processes becomes an integrated part of operations and strategy. First, the POEM concept is introduced. Because this concept addresses some issues similar to those of quality management, the possibilities of using insights from total quality management (TQM) in developing POEM are investigated. Based on an overview of the literature and conceptual studies of TQM, a coherent set of several elements are described that can contribute to the organization of POEM. These elements are grouped in a framework, the POEM matrix, which can be used to guide research within this emerging area of organizing for the environmental characteristics of products. This matrix could also provide guidance to practitioners by delivering an integrated perspective on the organizational elements that are conducive to organizing POEM. An example from case study research in the chemical industry illustrates such an application of the matrix.

Address correspondence to:
Frank G. A. de Bakker
Faculty of Social Cultural Sciences
Department of Public Administration and Communication Sciences, DBL 859
Vrije Universiteit
De Boelelaan 1081-c
1081 HV Amsterdam, The Netherlands
fga.d_bakker@scw.vu.nl

Volume 5, Number 2

Introduction

With the continuing rise of environmental awareness, the environmental effects of products are becoming increasingly important to industrial organizations. The enthusiasm for additional measures for the environmental improvement of production processes in several industrial sectors is decreasing, and emphasis is gradually shifting toward more integrated approaches. Industrial ecology considers themes such as energy and materials consumption, waste minimization, and interorganizational cooperation (e.g., Frosch and Gallopoulos 1989; Graedel and Allenby 1995). Such an integrated approach is visible, for example, in the increased attention being given to product-oriented environmental measures. According to Kärnä (1999), the growing attention to products' environmental characteristics at a company level has several motivations:

- Products have a significant environmental impact
- Environmental policies increasingly focus on products, for instance, through extended producer responsibility or integrated product policy
- Manufacturers are in a position to influence products' environmental characteristics because of their influence on the product development process
- Manufacturers, because they are located in a central position in the product life cycle, have to deal with many different stakeholders

Firms thus will have to develop ways to organize themselves for this environmental product demand. Increasingly, attention is being paid to concepts with names such as "design for environment" (DfE), "green concurrent engineering," or "environmentally conscious design and manufacturing" (OTA 1992; Karlsson 1997; Zhang et al. 1997; van Hemel 1998; Kärnä 1999; Borland and Wallace 2000) that focus on decreasing the environmental impact of products. Many studies examine the use of such concepts, and the creation of tools to provide product developers with information regarding a product's environmental performance is ongoing (Wenzel et al. 1997; Troge 2000). Life-cycle assessment is one well-known analytical tool intended to evaluate the environmental profile of a product (Keoleian 1993). Some other tools include information systems (Shaft et al. 1997; Sharfman et al. 1997).

Although much theoretical work has been done in the fields of environmental strategy, corporate environmental management, and environmental product design, relatively little attention has been paid so far to an organizational focus on products' environmental aspects (Lenox and Ehrenfeld 1997; Cramer 1998). How can a firm focus on this new product requirement, which is not only an aspect of design but is also important during the entire product life cycle and also affects a firm's processes? I intend to contribute to the understanding of the organizational aspects of product-oriented environmental management (POEM) by applying theoretical insights from quality management to this emerging area of theory and practice. In brief, POEM can be defined as an approach for organizing and operating a firm in such a way that improving the environmental performance of its products becomes an integrated part of operations and strategy. In the next section, a further introduction to POEM is given.

The aim of this article is to develop an analytical framework for examining and organizing POEM, using insights from quality management.[1] This theoretical framework can be used to guide research on organizing for the environmental management of products. Consequently, by delivering an integrated perspective on the organization of POEM, the framework can be considered to be a starting point for the provision of guidance to practitioners. The insights applied mainly stem from total quality management (TQM), because this is the most integrated approach to quality management. According to Taylor and Pearson (1994), TQM can be defined as systematic organization to ensure efficient execution of appropriate tasks to achieve total quality. Total quality is then seen as a firm's coordinated commitment to achieving quality at each stage of a product's or a service's life span, with quality being a relative measure of performance.

This relationship between environmental management in general and quality management has been addressed before (Welford 1992; Klas-

sen and McLaughlin 1993; Hanna and Newman 1995; Wever 1996; Laudise and Taylor-Smith 1999). Yet, comparing TQM specifically to POEM seems to be appropriate for several reasons. First, both management concepts concern products and processes.[2] This makes quality management a suitable basis for investigating POEM, because both are concerned with such integrated approaches. Second, both concepts are aimed at prevention, working toward a more proactive attitude, for example, through continuous improvement. Third, both concepts apply a chain perspective, looking beyond the borders of the individual firm into the product chain. Fourth, technological and organizational changes are important in both management practices, while both concepts aim to go beyond the mere development of tools. Fifth, by using insights from quality management in POEM, firms could be more open to POEM-like ideas, because most firms are already aware of the principles of quality management. Finally, both management concepts could apply the idea of "stretching goals" (Hamel and Prahalad 1994; Cramer 1997). A substantial misfit is deliberately created between a firm's quality or environmental competencies and objectives in order to encourage substantial improvements in performance.

To develop the argument that POEM could benefit from TQM, an overview of POEM is given in the next section, followed by a review of some conceptual elements of TQM. Subsequently, TQM is linked to POEM, resulting in a framework for analysis. This framework, the POEM matrix, can be used both to embed the concept of POEM within the context of management and organizational theory and, accordingly, to provide guidance to practitioners. Examples from case study research are given to illustrate some possible applications of this matrix. The approach being followed is then discussed, and directions for further research are presented, concluding with some final remarks.

Product-Oriented Environmental Management

Over the last decade, attention to products' environmental characteristics has grown rapidly. In various countries, environmental policies increasingly focus on products (Oosterhuis et al. 1996; Kärnä 1999). Concepts such as extended producer responsibility are being developed through policies such as the European directive on Waste Electrical and Electronic Equipment (Mayers and France 1999) or integrated product policy (Berkhout and Smith 1999; Schmidt 2000). Cooperative approaches and negotiated voluntary agreements play an important role in these policies (Harrison 1999), because different stakeholders such as firms, industry associations, and special interest groups including environmental and consumer groups are involved. As an illustration, the Dutch situation is highlighted briefly below.

In the Netherlands, a program for POEM has been developed with close cooperation between government and business (Rocha and Brezet 1999). Building on earlier developments in environmental policy, such as environmental management systems and integrated chain management (ICM),[3] the Dutch Ministry of Environment proposed a concept of POEM that is focused on prevention. The awarding of government grants stimulated the development of the concept, resulting in a guidebook for POEM (VROM 1999). In applying POEM, a firm takes a responsibility to pay systematic attention to decreasing the total environmental burden of its products across the entire product life cycle. A firm thus needs to develop insights into their products' environmental characteristics, needs to establish contacts with regard to environmental issues with chain partners such as suppliers or customers, and needs to systematically embed this way of working in its processes.

To manage products' environmental characteristics, a firm has to possess or develop various capabilities; an organizational perspective on POEM therefore could be useful. The Dutch guidebook for POEM (VROM 1999), therefore, is based on a plan-do-check-act cycle, known from quality management. This again highlights the relevance of the relationship between these management concepts, as further discussed within this article.

The amount of research on POEM and related concepts is gradually increasing. Journals such as the *Journal of Cleaner Production*, the *Journal of Sustainable Product Design*, and the

Journal of Industrial Ecology regularly pay attention to products' environmental characteristics and management implications. Some recent publications include those of Shaft and colleagues (1997), Mayers and France (1999), Rocha and Brezet (1999), and Simon and colleagues (2001). In the remainder of this article, aspects of POEM related to TQM are presented. Therefore, first an overview of TQM literature is given.

Elements of TQM

The quality movement had already existed for some decades, when during the 1980s, the concept of TQM surfaced. Although its uniqueness can be contested (e.g., Dean and Bowen 1994; Hackman and Wageman 1995; Boaden 1996), the concept of TQM has become very popular and found its way into many different applications in organizational management. Countless firms have been experimenting with TQM-like concepts, and a large body of research and practical managerial literature has evolved. Most of this material, however, is mainly based on studies focusing on a specific situation in one firm or branch of industry. Apparently, it is not easy to generalize specific quality management findings. Yet, based on some more theoretically grounded studies, TQM is examined here for any guidance it could provide for POEM. The main characteristics of TQM, its relationship with different organizational models, and its integrative aspects are considered. This examination is not intended to be a complete overview of TQM ideas; rather it should identify those elements that could be useful for guiding POEM.

Main Characteristics of TQM

Hackman and Wageman (1995) compared current TQM explanations with the work of some of the founders of quality management, Juran, Deming, and Ishikawa. They found (1995, 310) that the "original" focus of TQM "is on the preservation and health of the organization, but there are also explicitly stated values about the organization's context (the community and customers) and about the well-being of individual organization members." They concluded that, according to these founders, five interventions together define the core of TQM. These interventions are summarized as customer focus, supplier partnerships, use of cross-functional teams, use of scientific methods to monitor performance, and use of process-management heuristics to enhance team effectiveness.

Comparing these "original" core interventions with current TQM practices shows both enrichments and divergences. Hackman and Wageman (1995) viewed competitive benchmarking and employee involvement as enrichments. Conversely, the current "greater emphasis on group-process techniques and interpersonal skills than on scientific methods" (1995, 317) and the increasing reliance on performance measurement and performance-contingent rewards to motivate and control employees are seen as diverging from the original ideas in TQM. Combining these original and current approaches, Dean and Bowen (1994) briefly summarized the main current TQM factors in three principles that are also regarded as core elements of TQM[4] in this article:

- Customer focus
- Continuous improvement
- Teamwork

TQM and Organizational Models

Quality management is rather practically oriented. In an effort to bridge the gap between TQM practice and management theory, Spencer (1994) examined the relationship of TQM to three types of organizational models in management theory: mechanistic, organismic, and cultural. In short, the *mechanistic* models can be regarded as approaches in which efficiency, conformity, and compliance are important. Spencer (1994) defined TQM as a spiritual descendent of the mechanistic model to emphasize the evident mechanistic influence on TQM. An example of this influence is the concept of "management by fact" in TQM and in mechanistic models more generally. The *organismic* models can be characterized as contingency approaches, indicating that the organization's situation dictates the correct management approach (Daft 1998). Spencer (1994) found that many TQM ideas were asso-

ciated with such organismic models, because managerial measures on quality management are to be tailored to the individual organization. The third organizational model, the *cultural* model, resembles a more constructivist approach. The cultural model, for instance, aims for constituent satisfaction rather than customer satisfaction. Organizations are seen "as a collection of cooperative agreements entered into by individuals with free will (Chaffee 1985)" (in Spencer 1994, 462). Such a model thus broadens the traditional customer focus in quality management into a stakeholder focus.

Considering these three models, a strict adherence, both by the scholar and the practitioner, to one type of organizational model is rejected: Cross-fertilization between different approaches could be more fruitful. Paying attention solely to instruments and techniques (the system-technical aspects) ignores the social-dynamic (organizational and cultural) aspects of such processes of change. Such an integrative way of thinking is inherent to TQM and might also benefit POEM.

An Integrative Approach: The TQM Matrix

Powell (1995) found that some critical TQM factors were executive commitment, open organization, and employee empowerment. He concluded (1995, 29) that "firms should focus their efforts on creating a culture within which these procedures can thrive." Furthermore, he found that TQM is apparently not *necessary* for success; more than merely adopting the "quality language," a firm should try to capture "the underlying intangible resources that make TQM implementation successful" (1995, 31). Olian and Rynes (1991) and Hackman and Wageman (1995) pointed to similar social-dynamic issues. Successful application of TQM apparently requires more than just adhering to the main principles and procedures. Obtaining a better understanding of the social-dynamic component of organizing such quality management could also support the more successful organization of the system-technical part. Similarly, Debackere and colleagues (1997, 201) pointed to the changing view of TQM that contrasts a "functionalist-positivist approach, viewing TQM as a set of tools, techniques and procedures, with a more interpretative-constructivist approach that frames TQM as a vehicle to enact change processes within the organization." Also they emphasized seeing TQM "as a rallying point, whose meaning, boundaries and deployment are constructed *gradually*, via an *iterative* process, and *interactively* by the actors involved in and continuously drawn into the process" (1997, 201, italics added). Taylor and Pearson (1994, 27) stated that none of the quality systems proposed by the founders are "entirely capable of meeting all the requirements of a complex organization, and most companies adopt a composite approach." Such statements can be interpreted as an appeal for an integrative approach to TQM, rather than sticking rigidly to one organizational model, be it mechanistic, organismic, or cultural. This line of reasoning is represented in the total quality matrix of Fisscher (1994). An adapted version of this matrix is shown in figure 1.

The matrix views TQM from a system-technical and a social-dynamic organizational viewpoint and at both operational and strategic levels. This matrix can serve as a framework for organizing and analyzing quality management. By including social-dynamic and strategic dimensions, it emphasizes that there is more to quality management than having appropriate operational management systems in place. To stress the centrality of teamwork, customer orientation, and continuous improvement in TQM literature, I have added these items at the core of the matrix. These core elements affect every quadrant. Ideally, a firm working with TQM pays attention to all quadrants of the matrix and to the core as well, aiming for a balance.

Finally, the "trick" to total quality goal setting is to make the goals so ambitious that they cannot be achieved merely by incremental improvements to business as usual (Olian and Rynes 1991). Goals therefore need to be stretched to encourage "quantum leaps" in performance, an idea also apparent in the work of Hamel and Prahalad (1994). The benefits of applying this idea to TQM are that it enables people to take another viewpoint (such as taking an internal customer perspective) and that it facilitates further cross-functional process improvements by en-

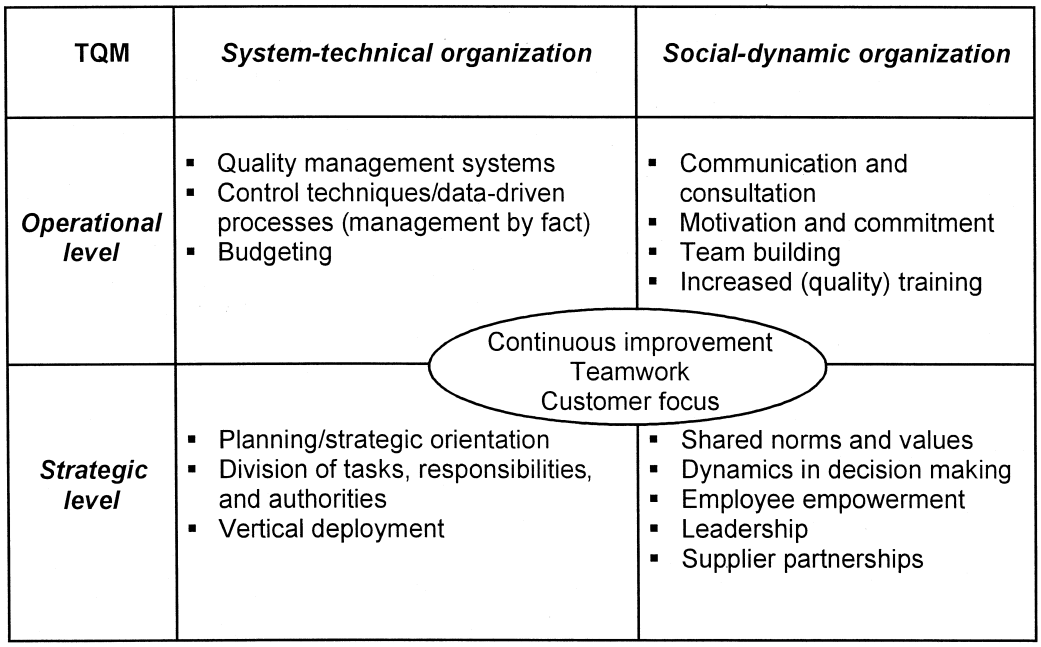

Figure 1 Total quality matrix. TQM = total quality management. *Source:* Adapted from Fisscher (1994).

abling people to speak the common language of quality (Olian and Rynes 1991). The elements of the matrix provide a coherent set of areas in which these stretched goals could be set.

TQM to Guide POEM: A Research Framework

As discussed, the integration of several approaches, considering both system-technical and social-dynamic aspects, and stretching goals are important elements in TQM. As noted in the introduction, there are several reasons to consider TQM elements in relation to POEM. The framework presented earlier therefore is now transformed into a POEM matrix. The combination of environmental management and quality management is first discussed further, followed by an outline of the different parts of the POEM matrix. In the section "An Empirical Example," the application of the POEM matrix is illustrated with some examples from case study research.

Environmental Performance as a Quality Objective

According to Spencer (1994, 447), TQM "claims that improving quality can decrease rather than increase costs and facilitate the attainment of other demands and objectives." One of those other objectives could be the organization and incorporation of POEM. Getting a firm to control not only its products' technical and economic performance but also the environmental performance could make a valuable contribution to both quality and environmental management. After all, such environmental characteristics can be regarded as elements of product quality.

TQM has been extended into total quality environmental management (TQEM). According to Shrivastava (1995), TQEM applies a total systems perspective and principles of quality management to environmental problems. TQEM has attracted quite a lot of attention over the last decade, for instance, through a dedicated journal, *Total Quality Environmental Management* (now *Environmental Quality Management*), and various other publications (e.g., Wever 1996). Most of this literature, however, is concerned with environmental management in general, focusing mainly on production *processes* or operations management (Klassen and McLaughlin 1993; Hanna and Newman 1995; Sarkis 1995; Angell and Klassen 1999). Because of its specific orientation on *products*, POEM is highlighted in this article. Over the last few years, some literature

on combining quality management and environmental management, from a product perspective, has appeared (e.g., Karlsson 1997). Yet, such studies mainly highlight product development, whereas POEM is concerned with environmental characteristics throughout the product life cycle. In addition to product development, topics such as end-of-life treatment and supply-chain management are addressed in POEM, which adopts a more strategic approach, looking beyond mere operational measures.

Stretching Environmental Goals: The POEM Matrix

As in quality management, the idea of stretching goals is also applied in environmental strategy, where Cramer (1997) pleaded for an approach "from fit to stretch." In environmental management, most firms are looking for a fit that matches their internal organizational competencies with the external environmental requirements. In a "stretch approach," a substantial misfit is deliberately created between competencies and objectives. Goals are set at a certain level of ambition. For POEM, this could imply not only looking for incremental improvements in a product's environmental performance, but also for some more radical changes, such as product system innovations or new concept developments (van Hemel 1998).

In setting such stretched environmental goals, people at different organizational levels need to be convinced of the feasibility of these new goals. Various items in the adapted TQM matrix could then be useful. Building on this matrix, a new framework therefore is developed, aimed at representing the important organizational elements involved in developing POEM. This POEM matrix, presented in figure 2, could be used both to embed the concept of POEM within theories of management and organization, and to provide practical guidance to practitioners. Both the form and the categories are identical to those of the TQM matrix. The inclusion of a number of common items is logical; both TQM and POEM aim at continuous improvement, which requires the inclusion of elements such as training and performance measurement. In addition, if the environmental performance of products is regarded to be an element of quality, then the use of some identical elements in the matrix also is consistent. To stress the coherence and continuity of the different quadrants, a dotted line has been added, indicating that the quadrants are not seen as rigid. The different levels of the matrix are briefly discussed.

Operational Level

Plans to change a firm's performance, for example, regarding the environmental performance of products, affect the *operational system-technical* level. At this level, one needs to determine which goals are achievable, probably through using forms of environmental performance measurement and information systems. Clearly, both performance measurement and information management are system-technical elements, emphasizing issues such as regulatory compliance and conformity. Budgeting is also treated as operational, because if one is to work with cross-functional teams (as is advocated in the operational/social-dynamic quadrant), placing budget responsibilities at this level can be beneficial through enhanced commitment.

In regard to POEM, *operational social-dynamic* elements could include increased training in the handling of environmental information (van Hemel 1998). Given the lack of familiarity with POEM in many organizations, cross-functional consultation and communication are possibly even more important here than in TQM implementation, as are motivation and commitment. Bringing in advisors could reduce this lack of familiarity. According to van Hemel (1998), such advisors played an important role in the success of new DfE strategies in the companies she studied. Integrating the various functions involved could possibly be achieved by using concepts such as green concurrent engineering (Karlsson 1997). Integration, communication, and cross-functionality hence are important aspects in this quadrant.

Strategic Level

The strategic level is also split into social-dynamic and system-technical elements. Two elements at the *strategic social-dynamic* level that differ from those in the TQM matrix are "transformational leadership," and "partnerships and

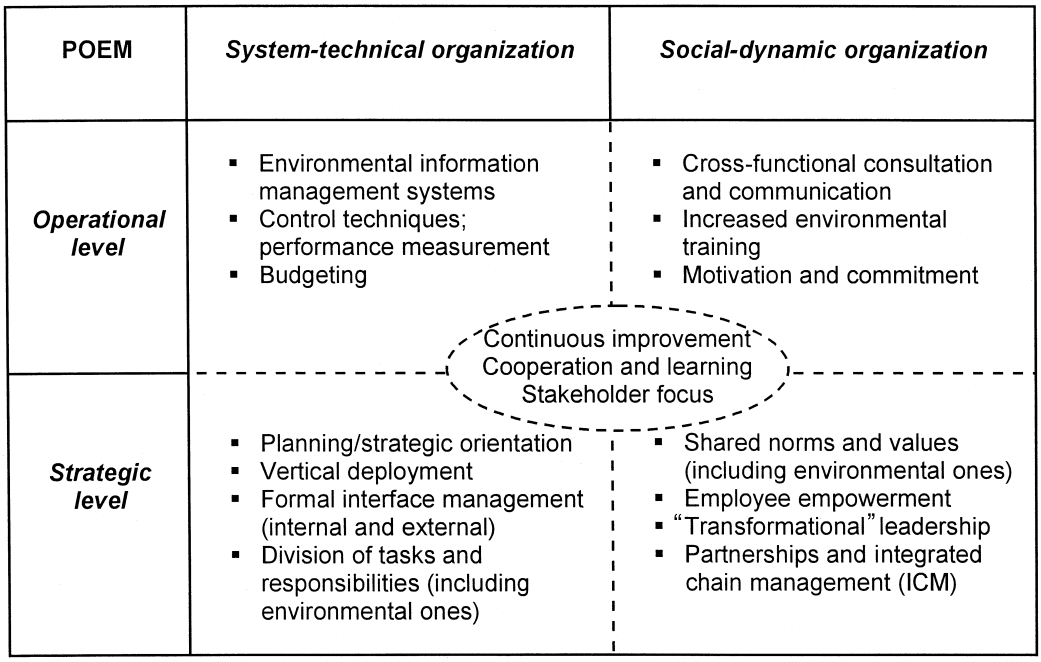

Figure 2 Product-oriented environmental management matrix. POEM = product-oriented environmental management.

ICM." These two differences are discussed briefly in this section. The other elements, employee empowerment and shared norms and values, remain relevant to both TQM and POEM.

According to Cramer (1997), in some environmental management literature, a type of transformational leadership is promoted, in which the management level develops green norms and values within a firm and keeps these norms and values alive. In practice, however, such an inspiration at senior management levels did not seem that apparent to her at that time. Before senior managers demonstrate transformational leadership they need to be convinced of its efficacy. Using more system-technical elements such as measurement and strategic orientation could possibly achieve this. This notion underscores the integrated character of the POEM matrix.

Secondly, supplier partnerships were mentioned in this quadrant of the TQM matrix. In the POEM matrix, this element is broadened to "partnerships and ICM." Possibly more so than in quality management, in POEM, the entire product life cycle is at stake. Besides suppliers, other partnerships might, for instance, address recycling or (reverse) logistics issues. The understanding that environmental problems are determined over the entire product life cycle in such chains has been permeating further, as have been novel approaches to tackling these problems. ICM, for instance, is the integrated management of a supply chain in terms of environmentally, socially, and economically responsible management of the production, consumption, distribution, and final disposal of a product (Cramer 1996) and thus is closely related to the POEM concept, but with a greater emphasis on materials (see also note 3). These issues are dealt with in this strategic social-dynamic quadrant of the POEM matrix.

At the *strategic system-technical* planning stage, the development of objectives, or measurable goals that a firm intends to achieve within a given time, occurs (Starik et al. 1996). Measurability is important in comparing a firm's performance with its environmental goals. Related to this is what Starik and colleagues (1996, 16) called strategic posture: "the organization describes its orientation towards how it will de-

velop 'green' characteristics." At this stage, environmental product characteristics are listed, product requirements are identified, and priorities are set. Hence, this is the moment when goals can be stretched, when a deliberate misfit could be pursued to make quantum leaps possible (Cramer 1997). A firm cannot, however, constantly make such quantum leaps. A good alignment with the firm's surroundings therefore remains important, as does information on the attainment of a firm's environmental goals. Information systems could also assist here, as demonstrated in other research. For instance, Shaft and colleagues (1997) proposed the concept of life-cycle-oriented environmental management, whereas Starik and colleagues (1996) developed an approach to regularly align a firm's environmental strategy with signals from its surroundings. This resembles the earlier remarks on the gradual, iterative, and interactive character of TQM.

The other strategic system-technical elements of the matrix comprise the involvement, at the senior management level, in changing tasks and responsibilities, and in the vertical deployment of POEM, that is, up and down the firm hierarchy. Task setting mainly takes place at the management level, whereas vertical deployment should be applied throughout the entire firm. I have added the topic of formal interface management, both inside and outside the firm. Both cross-functional activities and joint operations, such as ICM, call for a more systematic approach to these interfaces. Its formal aspects are located in this quadrant (for example, creating supportive structures), whereas the more informal aspects of interface management can be observed in the social-dynamic quadrants (such as innovation and commitment or shared norms and values).

Core of the Matrix

The core of the matrix is partly changed, compared to the core of the TQM matrix. The term "continuous improvement" remains unchanged because this is of importance to both TQM and POEM and remains applicable to all four quadrants.[5] The term "teamwork" is broadened to "cooperation and learning" to emphasize the larger scale. In POEM not only is intrafirm cooperation important (such as cross-functional design activities), but interfirm cooperation also plays a role (in ICM, for instance). System-technical aspects such as interface management and budgeting are relevant in facilitating this cooperation. The addition of the term "learning" stresses the continuity and the iterative character of the POEM organization process. Finally, the term "customer focus" is broadened to "stakeholder focus." Without entering into a discussion on what makes a stakeholder, clearly, in relation to POEM, more parties are involved than just customers. Various researchers (e.g., Garrod and Chadwick 1996; Fineman and Clarke 1996) have shown that customers and regulation are considered important stakeholders with respect to general environmental management issues. In his "natural resource-based view of the firm," Hart (1995, 1001) proposes that "firms that adopt product-stewardship strategies will evidence inclusion of external stakeholders in product-development and planning processes." Recent empirical work by Sharma and Vredenburg (1998) also points in this direction, presenting environmental stakeholder integration as one important competitive capability, in addition to, for instance, learning and continuous innovation. In considering stakeholders, it should be noted that internal stakeholders can play an important role as well (van Hemel 1998). The cultural organization models' aim of "constituent satisfaction," hence, is reflected here by considering both internal and external constituents.

An Empirical Example

Following this broad treatment of the POEM matrix, it is useful to present some possible applications of this matrix. Several studies have focused on specific elements of POEM. DfE and eco-design, for example, were studied by Lenox and Ehrenfeld (1997) and by van Hemel (1998). I have studied POEM within a chemical firm (labeled here as "ChemFirm") through a case study methodology. Based on a series of interviews, document study, and a presentation, a wealth of information was obtained that was analyzed using the items in the POEM matrix. Instead of just eco-design, the entire organization of POEM

was made central in this case study, which is briefly presented here. This case study was part of an ongoing research project.

Within the chemical industry, POEM is often carried out as part of the so-called Product Stewardship (PS) code, which is an element of the Responsible Care program. Responsible Care is a chemical industry voluntary initiative, developed as a set of guiding principles regarding environmental, health, and safety issues. This initiative consists of six codes of practice, aimed at continuously improving performance and at communicating this improved performance (Howard et al. 1999). The PS code addresses the management of the environmental, health, and safety effects of a product throughout its entire life cycle. Although the scope of PS is broader than that of POEM, because of the inclusion of health and safety issues, studying the organization of PS can deliver valuable insights into organizational aspects of product-oriented management.

One of the business units of ChemFirm produced powder-coating resins and operated in a growth market. Environmental issues in general were important to its customers, because environmental characteristics were one of the major selling points of these resins. To improve cooperation among product development, manufacturing, and marketing, the business unit installed an "operational team" (OT), consisting of representatives of different functions in the firm. These teams bore profit responsibility and were meant to create a better market orientation. The product manager served as a team manager. As responsibility for PS was given to the OT, the team manager cooperated with the business unit's technology manager to develop a PS approach with the team. In this way, PS projects were defined and most team members were assigned a project. Most projects were externally oriented, aimed mainly at customers and suppliers, because communication and risk management were seen as the main issues in PS. Interviewees estimated that, regarding the organization of PS, sufficient knowledge was available, but that experience with the PS concept should grow.

System-technical operational elements. Various management systems were in place, such as certification under the International Standards Organization's ISO 14001 standard. Risk management was a central issue in the corporate safety and environmental management system. A "translation" toward products was not yet developed, but data management was also being reviewed as part of the PS project. Budgeting was also mentioned at this operational level because the OT had profit responsibility, and PS expenses had to be paid out of their existing budgets.

Social-dynamic operational elements. An important feature in this case study was the fact that the PS organization paralleled the operational structure. Because of the presence of OTs, no additional structure had to be created. The OT already was responsible for the operational decisions concerning the product. Product-oriented environmental issues therefore fit in well.

Social-dynamic strategic elements. Shared norms and values regarding environmental issues in general could be observed. The creation of an OT can be regarded as an act of employee empowerment. Most interviewees saw themselves as influential in the further success of PS. Ideas were being developed regarding partnerships and chain management. In general, there were many contacts with chain partners, but environmental issues were not often discussed, contrary to safety issues, which are another important feature in PS.

System-technical strategic elements. The OT structure was rather recent and appeared to be a suitable structure for getting a better market orientation. Within the firm, people often shift positions, making a good transfer of knowledge necessary. Having such knowledge spread over a team of persons makes the process less vulnerable to disruption, hence improving its continuity. Although their reactions varied, most interviewees expected PS to increase in significance, if other issues did not surpass it. Formalized interface management took place but not so much with regard to environmental issues. Industry associations or industrial platforms played a role in addressing these issues and in promoting the Responsible Care program and PS.

Core of the matrix. Continuous improvement suggests that PS should be regarded as a continual process, just as it is in quality management. Keeping a clear view of the related elements in-

volved in PS using a framework for analysis such as the proposed POEM matrix can help focus and continually improve the process. This continuous improvement also implies that in the longer run, PS should also focus on internal issues. Cooperation, both internally and externally, is important for creating more support for PS. Internally, this was taken care of by the creation of OTs. This cross-functional team, however, needed to receive ample support from higher management to fulfil its PS tasks, while learning how to deal with products' environmental properties was also important. A strong emphasis on communication is found in the stakeholder focus, because a more open approach toward the "general public," neighbors or interest groups ties in with the PS approach. An interplay between the quadrants of the matrix then seems necessary.

Discussion and Concluding Remarks

In this article, the possibilities of applying insights from TQM to the organization of POEM have been investigated. Because POEM could encounter problems similar to those encountered by TQM, I have argued that it is useful for its development to try to learn from quality management. Some valuable lessons might be gained from those experiences. First, several reasons for specifically using TQM insights in the organization of POEM were presented. Important quality management elements were listed and presented in a matrix, considering the system-technical and the social-dynamic aspects of an organization at both strategic and operational levels. Building on the analogy between TQM and POEM, that framework was transformed into another matrix, which can be used to analyze the organization of POEM within a firm. The application of this POEM matrix has been briefly illustrated through a case study in the chemical industry. Here is a brief discussion of the approach that was taken.

First, in the attention given to environmental management, a shift from processes toward products was observed. As discussed earlier, environmental product orientation denotes giving attention to the entire product life cycle. In modeling quality management, product orientation is normally seen as the first stage of quality development. The next stages are process orientation, systems orientation, chain orientation, and finally TQM. Combining POEM and quality management then might seem to be contradictory. The product orientation in POEM could, however, probably best be compared with a chain orientation in quality management, or even with TQM. This makes combining insights on TQM and POEM a logical step. I continue to use the term "*product-oriented* environmental management," because the product life cycle is central in the presented approach.

Secondly, in quality literature, attention is broadening beyond customers toward other *stakeholders*. An example of this is the inclusion of broad terms such as "impact on society" in quality awards and models, such as the European Foundation for Quality Management model. Standards such as the ISO 14000 series or the Eco-Management and Audit Scheme (EMAS) have not been addressed in this article because currently these are mainly process oriented. To be of service to the development of POEM, such standards and models should pay closer attention to the environmental aspects of products. In future research, a link between these standards and models and POEM-like approaches needs to be pursued. Until POEM is incorporated adequately into these standards, treating POEM separately is justified.

Thirdly, the aspects of *integration and improvement* must be stressed again, because these are crucially important to both TQM and POEM. Incorporating both system-technical and social-dynamic elements in a continuous effort when organizing POEM is necessary, both at the operational level and at the strategic level. In its current form, the matrix indicates a number of related elements of POEM. The combination of several organizational models in the matrix emphasizes the need for integration. This should be developed in more detail, highlighting the relationships between the elements in the matrix. Different types of firms could have different configurations in their individual POEM matrix depending on, for example, which elements are stressed in a firm's activities or in the sector a firm operates in. Although difficult, it is clear

that in fine-tuning POEM, attention has to be paid to the "hard-tangible" cultural aspects.

Combining insights from quality management and environmental management also received some criticism, due to, for instance, the often-prescriptive character of much quality literature. Definitions of what quality is tend to differ enormously. Little consensus on quality issues exists, most quality literature highlights only one, or a few, typical cases, and often theoretical frameworks are not constructed. A danger exists that environmental management literature could follow the same trends. An approach such as POEM, however, might serve a bridging function between TQM and environmental management and might at the same time contribute to identifying weaknesses of both practical management areas. Because integration is an important issue in both areas, an integrative approach might be able to bring them closer together. Both areas would benefit from a more thorough theoretical development, but they also need to stay firmly embedded in practice. The POEM matrix offers a framework for linking these different goals.

Further warnings on a combination of insights from quality management and environmental management were given by Roome (1992). First, environmental awareness is considered more difficult to introduce than quality issues, mainly because of its more complex nature. A product's environmental characteristics might be harder to comprehend than its quality. By treating a product's environmental performance as an element of company performance, and dealing with it according to the POEM matrix, environmental issues may become more tangible and intelligible. Unraveling the possible competitive advantages (e.g., Sharma and Vredenburg 1998) associated with a POEM-like approach could contribute to this. A second warning concerns the stakeholder focus. According to Roome (1992), customers are the final arbiters in quality issues. Environmental issues do not have such readily identifiable customers: They are stakeholder led. Although there are many stakeholders, the POEM matrix offers an integrative framework in which both internal and external stakeholders can be addressed. Furthermore, quality management also is increasingly becoming stakeholder led as, for instance, partnerships are becoming more important.

In addition, it should be noted that much TQM literature is based on U.S. research. Therefore, care should be taken in transferring theseresults to a broader context. Especially with a topic so sensitive to cultural aspects (such as learning or liability), research findings based in one business culture might not be directly applicable in another. Because this article is exploratory, I have chosen to maintain a broad view of the quality management and POEM literature.

A final remark concerns the limited empirical testing of the matrix presented in this article. This certainly needs attention in future research. As presented, the POEM matrix is considered to be a provisional framework based on theory, which through gradual, iterative, and integrative processes, could grow into a mature, empirically and theoretically grounded approach. Further links between this matrix and empirical experiences need to be established. The case study presented indicates one possible application of such an approach. As Hackman and Wageman (1995, 339) stated with respect to TQM, "for only if the improvement idea comes to apply TQM itself will this provocative philosophy have a chance of sustaining over time." This prediction could equally apply to POEM. Using an analytical framework such as the proposed matrix could help to focus and continuously improve the POEM approach by delivering a continuous and integrated view of the related aspects of POEM. Hence, using TQM insights for the organization of POEM appears to be a fruitful approach, contributing to the further enhancement of industrial ecology (IE) as well. As Laudise and Taylor-Smith (1999, 25) suggested, "we propose the integration of . . . quality concepts into the IE paradigm to ensure the most effective reduction of IE principles to environmentally conscious manufacturing practice." Further research could strengthen both the theoretical and practical basis for POEM and IE.

Notes

1. The ideas presented in this article are discussed in more detail in my Ph.D. thesis (de Bakker 2001).
2. Although the concept is termed "product-

oriented environmental management," it often follows after a range of process-oriented measures. Furthermore, if the entire product life cycle is considered, both the product and the way it is produced are examined.

3. The integrated chain management concept is related closely to the definition of POEM applied in this article, because it considers the material cycle from cradle to grave (Wolters et al. 1997). POEM, however, does not focus on materials as such, but on products, which can make the application of a chain perspective more tangible for firms. Of course, attempts to label the life cycle or product chain as exclusively product-based or material-based phenomena are prone to debate because products consist of materials. To emphasize the central role of manufacturing firms in determining product characteristics, including material selection, the POEM concept is considered to be most appropriate for this article. I want to thank Reid Lifset and an anonymous reviewer for bringing this issue to my attention.
4. The summary of TQM elements provided by Dean and Bowen (1994) corresponds with other listings of essential elements of quality management. Hardjono and colleagues (1996), for instance, list framing (focusing energy and needs), alignment, deployment, and continuous improvement as key elements.
5. Instead of "continuous improvement," the term "continual improvement" might be better to highlight the fact that improvement demonstrates more a repetitive character than a permanent nature. Yet, because the dominant terminology in quality management speaks of "continuous," I stick with this term.

Acknowledgments

This article is mainly based on research that was conducted at the Faculty of Technology and Management of the University of Twente, the Netherlands. Earlier versions of this article have been presented and discussed at the 1998 European Doctoral Summerschool on Management of Technology in Leuven, Belgium, and the 1999 LAiOOB Conference in Amersfoort, the Netherlands. I also want to express my gratitude to Antoni Brack, Olaf Fisscher, three anonymous reviewers, and Reid Lifset for their helpful comments on earlier versions of this article.

References

Angell, L. C. and R. D. Klassen. 1999. Integrating environmental issues into the mainstream: An agenda for research in operations management. *Journal of Operations Management* 17: 575–598.

Berkhout, F. and D. Smith. 1999. Products and the environment: An integrated approach to policy. *European Environment* 9(5): 174–185.

Boaden, R. J. 1996. Is total quality management really unique? *Total Quality Management* 7: 553–570.

Borland, N. and D. Wallace. 2000. Environmentally conscious product design: A collaborative Internet-based modeling approach. *Journal of Industrial Ecology* 3(2/3): 33–46.

Cramer, J. M. 1996. Experiences with implementing integrated chain management in Dutch industry. *Business Strategy and the Environment* 6: 38–47.

Cramer, J. M. 1997. Prioriteiten binnen het vakgebied milieumanagement. [Priorities within the field of environmental management.] *Milieu* 1997/5: 244–250.

Cramer, J. M. 1998. Responsiveness of industry to eco-efficiency improvements in the product chain. Paper presented at the Seventh Greening of Industry Network Conference, 15–18 November, Rome, Italy.

Daft, R. L. 1998. *Organization theory and design*. Sixth edition. Cincinnati: South Western College Publishing.

Dean, J. W. and D. E. Bowen. 1994. Management theory and total quality: Improving research and practice through theory development. *Academy of Management Review* 19: 392–418.

Debackere, K., B. Van Looy, and J. Vliegen. 1997. A process view on managing quality during the creation of technical innovations: Lessons from field research. *R&D Management* 27: 197–211.

de Bakker, F. G. A. 2001. Product-oriented environmental management: A study of capability-building, stakeholder orientation and continuous improvement regarding products' environmental characteristics in firms. Ph.D. thesis, Twente University Press, Enschede, the Netherlands.

Fineman, S. and K. Clarke. 1996. Green stakeholders: Industry interpretations and response. *Journal of Management Studies* 33: 715–730.

Fisscher, O. A. M. 1994. *Kwaliteitsmanagement en bedrijfsethisch handelen*. [Quality management and acting according to business ethics.] Inaugural address, University of Twente, Enschede, the Netherlands.

Frosch, R. A. and N. E. Gallopoulos. 1989. Strategies

for manufacturing. *Scientific American* (September): 94–102.

Garrod, B. and P. Chadwick. 1996. Environmental management and business strategy: Towards a new strategic paradigm. *Futures* 28: 37–50.

Graedel, T. E. and B. R. Allenby. 1995. *Industrial ecology*. Englewood Cliffs, NJ: Prentice Hall.

Hackman, J. R. and R. Wageman. 1995. Total quality management: Empirical, conceptual, and practical issues. *Administrative Science Quarterly* 40: 309–342.

Hamel, G. and C. K. Prahalad. 1994. *Competing for the future*. Boston: Harvard Business School Press.

Hanna, M. D. and W. R. Newman. 1995. Operations and environment: An expanded focus for TQM. *International Journal of Quality and Reliability Management* 12(5): 38–53.

Hardjono, T. W., S. ten Have, and W. D. ten Have. 1996. *The European way to excellence: How 35 European manufacturing, public and service organisations make use of quality management*. Brussels: Directorate-General III Industry, European Commission.

Harrison, K. 1999. Talking with the donkey: Cooperative approaches to environmental protection. *Journal of Industrial Ecology* 2(3): 51–72.

Hart, S. L. 1995. A natural-resource-based view of the firm. *Academy of Management Review* 20: 986–1014.

Howard, J., J. Nash, and J. Ehrenfeld. 1999. Industry codes as agents of change: Responsible care adoption by U.S. chemical companies. *Business Strategy and the Environment* 8: 281–295.

Karlsson, M. 1997. Green concurrent engineering: Assuring environmental performance in product development. Licentiate thesis, International Institute for Industrial Environmental Economics, Lund.

Kärnä, A. 1999. *Managing environmental issues from design to disposal—a chain reaction?* Licentiate thesis, Federation of Finnish Electrical and Electronics Industry, Helsinki.

Keoleian, G. A. 1993. The application of life cycle assessment to design. *Journal of Cleaner Production* 1: 143–149.

Klassen, R. D. and C. P. McLaughlin. 1993. TQM and environmental excellence in manufacturing. *Industrial Management and Data Systems* 93(6): 14–22.

Laudise, R. A. and R. E. Taylor-Smith. 1999. Lucent industrial ecology faculty fellowship program. *Journal of Industrial Ecology* 4(2): 15–27.

Lenox, M. and J. Ehrenfeld. 1997. Organizing for effective environmental design. *Business Strategy and the Environment* 6: 187–196.

Mayers, K. and K. France. 1999. Meeting the "producer responsibility" challenge: The management of waste electrical and electronic equipment in the UK. *Greener Management International* (spring): 1–16.

Olian, J. D. and S. L. Rynes. 1991. Making total quality work: Aligning organizational processes, performance measurements, and stakeholders. *Human Resource Management* 30: 303–333.

Oosterhuis, F., F. Rubik, and G. Scholl. 1996. *Product policy in Europe: New environmental perspectives*. Dordrecht: Kluwer.

OTA (Office of Technology Assessment). 1992. *Green products by design—Choices for a cleaner environment*. Washington, DC: U.S. Congress Office of Technology Assessment.

Powell, T. C. 1995. Total quality management as competitive advantage: A review and empirical study. *Strategic Management Journal* 16: 15–37.

Rocha, C. and H. Brezet. 1999. Product-oriented environmental management systems: A case study. *Journal of Sustainable Product Design* (April): 30–42.

Roome, N. J. 1992. Developing environmental management strategies. *Business Strategy and the Environment* 1(1): 11–24.

Sarkis, J. 1995. Manufacturing strategy and environmental consciousness. *Technovation* 15(2): 79–97.

Schmidt, W.-P. 2000. Integrated product policy (IPP). *International Journal of Life Cycle Analysis* 5: 73–74.

Shaft, T. M., R. T. Ellington, M. Meo, and M. P. Sharfman. 1997. A framework for information systems in life-cycle-oriented environmental management. *Journal of Industrial Ecology* 1: 135–148.

Sharfman, M., R. T. Ellington, and M. Meo. 1997. The next step in becoming "green": Life-cycle oriented environmental management. *Business Horizons* 40 (May–June): 13–22.

Sharma, S. and H. Vredenburg. 1998. Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities. *Strategic Management Journal* 19: 729–753.

Shrivastava, P. 1995. Environmental technologies and competitive advantage. *Strategic Management Journal* 16: 183–200.

Simon, M., G. Bee, P. Moore, J.-S. Pu, and C. Xie. 2001. Modelling of the life cycle of products with data acquisition features. *Computers in Industry* 45: 111–122.

Spencer, B. A. 1994. Models of organization and total quality management: A comparison and critical

evaluation. *Academy of Management Review* 19: 446–471.

Starik, M., G. M. Throop, J. R. Doody, and M. E. Joyce. 1996. Growing an environmental strategy. *Business Strategy and the Environment* 5: 12–21.

Taylor, R. and A. Pearson. 1994. Total quality management in research and development. *TQM Magazine* 6(1): 26–34.

Troge, A. 2000. Life cycle assessment and product-related environmental policy. *International Journal of Life Cycle Analysis* 5: 195–200.

van Hemel, C. G. 1998. EcoDesign empirically explored: Design for environment in Dutch small and medium sized enterprises. Ph.D. thesis, Delft University of Technology, Delft.

VROM (Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieu). 1999. *Handreiking Productgerichte Milieuzorg: Milieumanagement in de productketen*. [Guidebook product-oriented environmental management: Environmental management within the product chain.] Den Haag, the Netherlands: Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieu.

Welford, R. J. 1992. Linking quality and the environment: A strategy for the implementation of environmental management systems. *Business Strategy and the Environment* 1(1): 25–34.

Wenzel, H., M. Hauschild, and L. Alting. 1997. *Environmental assessment of products: Methodology, tools and case studies in product development*. London: Chapman and Hall.

Wever, G. 1996. *Strategic environmental management: Using TQEM and ISO 14000 for competitive advantage*. New York: Wiley.

Wolters, T., P. James, and M. Bouman. 1997. Stepping-stones for integrated chain management in the firm. *Business Strategy and the Environment* 6: 121–132.

Zhang, H. C., T. C. Kuo, H. Lu, and S. H. Huang. 1997. Environmentally conscious design and manufacturing: A state-of-the-art survey. *Journal of Manufacturing Systems* 16: 352–371.

About the Author

Frank de Bakker is an assistant professor in strategic management at the Vrije Universiteit, the Netherlands.